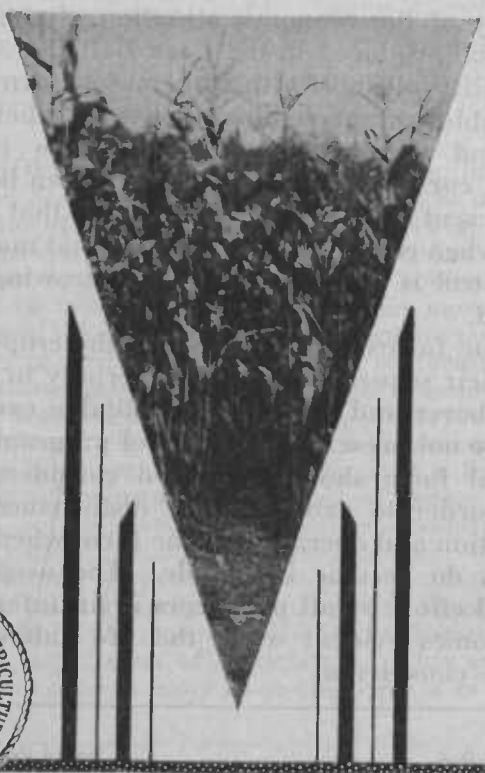
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1681

ADJUSTING CORN BELT FARMING TO MEET CORN-BORER CONDITIONS



THE EUROPEAN CORN BORER is recognized as a dangerous enemy of the corn crop. It has already caused serious damage in heavily infested areas in Ontario, Canada. Its eradication is considered economically impossible but it is believed that the injury may be kept at a point so low that little commercial damage will occur during normal seasons. This can be done by using control measures and practices that have proved to be effective.

The natural tendency of producers may be to substitute other crops for corn in an attempt to avoid loss, but the much lower value of other crops that can be grown in the Corn Belt, and the loss of farm feed, will mean that producers eventually will retain corn in the important place it now holds in the organization of farms in the Corn Belt.

A study of the economic situation of cash crops that can be produced in the Corn Belt indicates the impossibility of substituting them for corn to any considerable extent without lowering their farm values and thereby lowering the farm incomes. However, corn-borer control measures can be added to the present farm operations at a cost that is insignificant when compared with the loss that may result if no control is practiced or if corn growing is discontinued.

On some farms some changes in the crops grown and in their sequence will aid materially in controlling the borer and may prove profitable even when borers are not present. The control program for the individual farm should be given consideration at once in order to avoid sudden disturbance of the organization and operation of the farm when control measures do become inevitable. The necessity of concerted effort by all producers in an infested district becomes evident when the life habits of the borer are considered.

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ADJUSTING CORN BELT FARMING TO MEET CORN-BORER CONDITIONS

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INTRODUCTION

THE EUROPEAN CORN BORER has continued to spread in the United States until it is now known to be at the edge of the important areas of surplus-corn production. (Fig. 1.) Appreciable damage to the corn crop in the Lake region has occurred only in small localities in northwestern Ohio and southeastern Michigan. This can not be taken as an indication that more extensive losses may not occur in the future, however. There are now sufficient numbers of borers in northwestern Ohio and southeastern Michigan to produce a serious infestation in a single season under favorable climatic conditions. Studies of the life history of the borer, and experiments in controlling it, have shown the economic impossibility of eradicating the insect or of confining it to a limited area. But the possibility of reducing the number of borers has been amply demonstrated, and indicates the possibility of continuing to produce corn with only small reduction in farm incomes.

Control measures,[2] consisting of completely utilizing or destroying the entire corn plant by feeding it to livestock, burning it, or plowing it under in the field, are recommended by the Bureau of Entomology, United States Department of Agriculture. This work may be done during the 10 months or more when the borer is in the larval or the pupal state.

[1] Recognition should be given V. B. Hart, of Cornell University, who started this study while temporarily employed by the Bureau of Agricultural Economics.

[2] For details concerning the life history of the corn borer and control measures, see Farmers' Bulletin 1548, The European Corn Borer, Its Present Status and Methods of Control.

These facts suggest that the farmer should study further the adjustments which he can make in the organization and operation of his farm to include necessary control measures with the least possible reduction in his income. The advisability of including these control measures under corn-borer conditions must be balanced against the advisability of making more drastic changes in long-established crop and livestock organizations. That the success of such a plan depends upon the concerted action of all producers in the locality is evident, since the borer's natural spread by flight may extend several miles in a season. Little additional labor or expense in actual control work should be incurred until a threatening

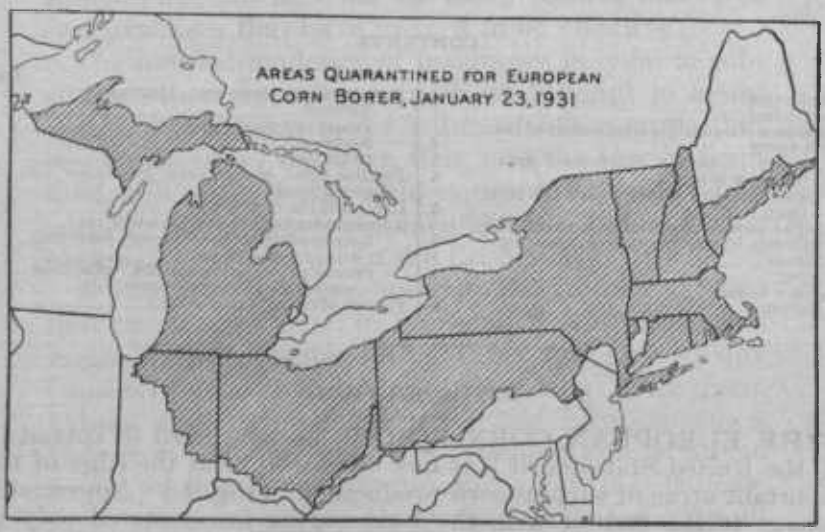

FIGURE 1.—The natural spread of the corn borer is by flight of the adult insect and varies annually with seasonal conditions

infestation becomes evident, but plans for a definite control program on each individual farm should be made at once to avoid sudden disturbance of the farm organization when the necessity for changes does arise.

The continued spread and the increased severity of the borer infestation may lead many producers to look for some other crop to take the place of all or a part of the corn in their rotations. The possibility of profitable substitution is limited. The purpose of this bulletin is to discuss the extent to which such substitutions are economically feasible and to indicate the possibility and to show the estimated cost of adjusting farm organization and operation to meet corn-borer conditions by adding control measures.

The general types of farming found in a given area are followed because they are believed to be the most profitable under existing conditions as determined by soil, topography, climate, available markets, transportation facilities, and other factors. These conditions are constantly changing and adjustments to meet these changes should be made. On the other hand, drastic changes are usually costly and should be made only after a careful study of the physical,

biological, and economic factors involved. The acreages of crops grown generally indicate the relative importance of those crops. This bulletin shows the relative importance of corn and other field crops on the basis of market value, feed production, and economic use of available labor and equipment. Production and consumption of the important cash crops will be discussed to show the economic situation of these crops. The possible methods of adjusting farm operations to include necessary control measures, and the economic feasibility of those methods under varying conditions, will be shown by discussing farm organizations typical of the district studied. Obviously, definite recommendations for specific adjustments to meet corn-borer

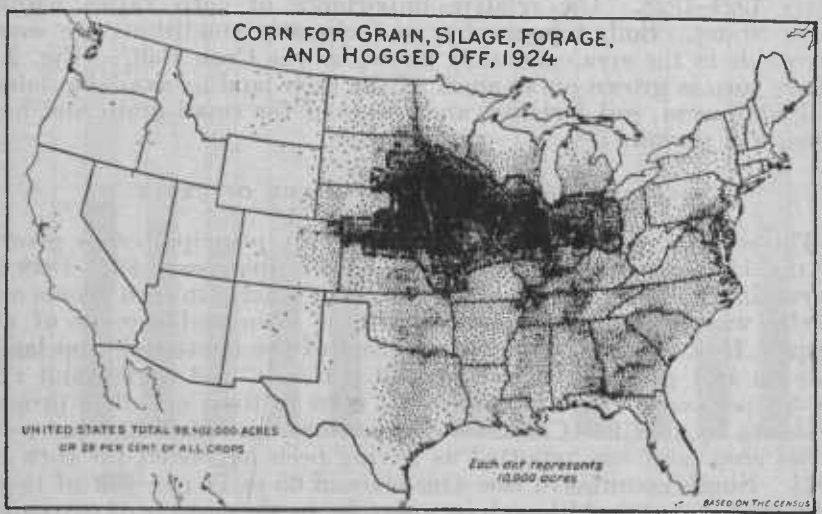

FIGURE 2.—The inclosed area produced 47.8 per cent of the total corn acreage of the United States in 1924. Nearly 44 per cent of the crop land in this area was planted to corn.

conditions can be made only after a detailed study of limited districts, and the final details must conform to conditions on the individual farm.

AREA STUDIED

This bulletin applies in general to the area commonly known as the Corn Belt, an area covering all or parts of 11 North Central States.[3] Differences in the life history of the borer, in the plants affected, and in the type of farming in the New England and Middle Atlantic States make the control problem in those States, different from that in the Corn Belt. Figure 2 shows the heavy concentration of corn in the Corn Belt. In this bulletin particular attention is paid to the area outlined on this map. Only those crops that are or may be grown in that area will be discussed as possible substitutes for corn. Farmers outside this important corn-growing area will face the control problem, but their relatively small acreage of corn per farm should present no serious clean-up problem.

[3] The 11 North Central States included are Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, and Kansas.

IMPORTANCE OF CORN IN THE ORGANIZATION OF CORN BELT FARMS

A study of the distribution, acreage, production, and value of corn in the United States shows the important place that this crop fills in the agriculture of the entire country and indicates that careful thought should be given to any plan for discontinuing corn growing or reducing the normal corn acreage. Corn is grown in every State and is especially important in the entire eastern half of the country; but it reaches its greatest prominence in the 11 North Central States. These 11 States included 62 per cent of the acreage and produced 71 per cent of the volume of all corn in the country during the five years 1924–1928. The relative importance of corn varies within these States. Soil, topography, and climatic conditions are most favorable in the area commonly known as the Corn Belt. (Fig. 2.) There corn is grown on as much of the crop land as available labor and equipment, soil fertility, and the need for small-grain and hay crops will permit.

ACREAGE, PRODUCTION, AND VALUE OF CROPS

The acreage, production, and value of the principal crops grown in the 11 North Central States during the five years 1924–1928 is shown in Table 1. The average of 62,189,000 acres in corn grown annually was equal to 36.3 per cent of the estimated acreage of all crops. Hay was grown on 21.7 per cent of the harvested crop land, oats on 18.4 per cent, wheat on 14.9 per cent, and barley and rye on 3.8 per cent. The importance of corn in the Corn Belt proper is shown by the 1925 Census of Agriculture, in which 43.6 per cent of its crop land was reported as having been harvested for corn in 1924. Single counties in this area showed 65 to 74 per cent of their crop land in corn. Although on many farms the acreage of corn may be greater than it should be from the standpoint of permanent soil fertility, the increasing use of legume crops, especially sweetclover, is making it possible to grow more corn in the rotation with increasing yields per acre.

TABLE 1.—*Acreage, production, and value of crops produced in the Corn Belt States: average, 1924–1928* [1]

Crop	Acreage harvested	Average yield per acre	Total production	Average value per unit	Total farm value
	1,000 acres	*Bushels*	*1,000 bushels*	*Dollars*	*1,000 dollars*
Corn	62,189	30.9	1,918,896	0.78	1,494,650
Wheat	25,628	15.0	385,112	1.23	472,666
Oats	31,474	33.2	1,045,671	.41	427,579
Barley	4,800	27.7	133,179	.61	81,802
Rye	1,674	14.7	24,547	.87	21,410
		Tons	*1,000 tons*		
Hay	37,150	1.4	51,881	11.05	573,197
Total	162,915				3,071,313
Estimated total, all crops	171,341				3,736,000

[1] Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, South Dakota, Nebraska, and Kansas. Estimates of crop reporting board, Bureau of Agricultural Economics.

During the above-mentioned 5-year period the farm value of corn was equal to 40 per cent of the estimated total value of all crops produced in the 11 States, and was nearly equal to the combined value of wheat, oats, barley, rye, and hay. The value of other crops, which include fruit, truck crops, canning crops, etc., was equal to 17.8 per cent of the value of all crops. Figure 3 shows the relative total value of corn and other crops produced in each of the 11 States during the five years 1924–1928. Although corn is the important crop in all of the Corn Belt (fig. 1), the relative importance of the small-grain crops varies with soil and climatic conditions. Winter wheat is important in the cropping system in Ohio and Indiana, and

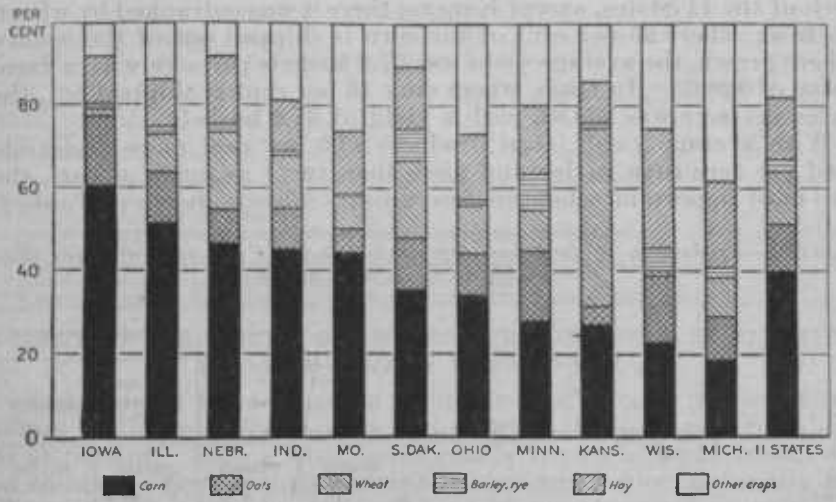

FIGURE 3.—RELATIVE VALUE OF CROPS PRODUCED IN CORN BELT STATES, 1924-1928

Iowa and Illinois are more typical of Corn Belt conditions than those States which lie largely outside the important corn-growing area.

along the southern edge of the Corn Belt in Illinois, Missouri, Nebraska, and Kansas. North of the winter-wheat area oats are the principal small-grain crop, and spring wheat is important in the extreme northern sections.

Although corn makes up a large part of the total value of all crops, it is significant that only 7.3 per cent of the cash farm income in the 11 States came from its sale. From 85 to 90 per cent of the corn crop in the United States is fed to livestock and is marketed as meat or other livestock product. Less than 10 per cent is used directly as human food, and less than 1 per cent is exported as grain. The relation of corn production to livestock production is indicated by the fact that on January 1, 1925, 70 per cent of all hogs in the United States, nearly 50 per cent of all steers over 1 year old, 38 per cent of the beef cows, and 23 per cent of the sheep, were in the 11 States which had produced nearly 70 per cent of the United States corn crop in 1924. Corn is a bulky product in relation to its value and is not shipped over long distances. However, much corn is sold for cash and shipped out of one district centering in eastern Illinois

and extending eastward into Indiana, and out of another district which includes western Iowa and adjacent portions of South Dakota and Nebraska.

ACRE VALUE OF CORN

Corn holds its important place in the organization of farms in the Corn Belt because of its relatively high value per acre, the large quantity of high-quality feed produced per acre, and the profitable use that can be made of labor and equipment in its production.

The average farm value of corn per acre in the 11 Corn Belt States during the five years 1924–1928 was $24.03, determined by yield per acre and price per bushel. It was the most valuable grain crop in each of the 11 States, except Kansas; there it was outranked by wheat. In Iowa, where 25 per cent of the corn is shipped out of the county where grown, the average yield was 37.6 bushels per acre with a farm value of $28.63. In Ohio, where only 16 per cent is shipped out, the value per acre was $30.82, with a yield of 37.2 bushels.

With average yields, corn produces 43.6 per cent more digestible feed per acre than barley and more than twice as much as oats, the two most important substitute feed crops. This is shown in Table 2.

TABLE 2.—*Production of feed and digestible nutrients per acre of corn, oats, and barley in Corn Belt States*

Feed crop	Average yield per acre, 1924–1928 [1]		Digestible nutrients	
			Per 100 pounds grain [2]	Per acre
	Bushels	*Pounds*	*Pounds*	*Pounds*
Corn	30.9	1,730	81.9	1,417
Barley	27.7	1,330	74.2	987
Oats	33.2	1,062	66.3	704

[1] 11 Corn Belt States. Higher yields are considered normal in the principal corn-growing area.
[2] From analyses of Feeds for Farm Animals, Bureau of Animal Industry, U. S. Department of Agriculture.

LABOR USED IN PRODUCING CORN AND OTHER CROPS

The amount of labor used in producing corn or any other crop varies in different localities and from farm to farm, depending on the kind and number of operations in preparing the seed bed and in harvesting the crop. Although corn production requires more labor than does the production of small grains, that labor is spread over a longer period, and the labor in harvesting comes at a time when little is required on other crops. Table 3 shows the amount of man labor used in growing and harvesting an acre of corn and an acre of the common small-grain crops, as shown by records kept by farmers in cooperation with various State experiment stations.

Under normal conditions and with a given amount of labor available, the acreage of corn which can be planted and given its first cultivation at the proper time, is the acreage which can be produced, for these two operations are the ones which require the most labor, and therefore fix the limits of the acreage. The distribution of the labor and the possibility of, for a few days, delaying some operations on corn in favor of work on more exacting crops, enable the Corn Belt farmer to utilize his available labor more completely in the

production of corn than in that of any other crop. The seasonal distribution of labor on corn, oats, wheat, and soybeans in east central Illinois is shown in Figure 4. The large amount of labor required on the small grains during the harvesting season is shown. The table also shows that the principal demand for labor on small grains comes when little labor on corn is necessary. This supplementary relationship between small grains and corn makes possible a more complete and profitable utilization of labor, power, and equipment through combining production of the different crops. (Table 3.)

TABLE 3.—*Man labor used per acre on grain crops in the Corn Belt States during selected years*

State and period	Corn [1]	Oats [2]	Wheat [2]	Barley [2]	Rye [2]
	Hours	*Hours*	*Hours*	*Hours*	*Hours*
Ohio,[3] 1920–1924	18.04	8.33	8.31	(4)	(4)
Illinois,[5] 1920–1926	14.14	6.77	11.16	(4)	(4)
Iowa,[6] 1925–1927	18.70	9.00	14.70	9.00	(4)
South Dakota,[7] 1922–1924	15.40	6.06	6.52	5.70	7.33

[1] Corn husked by hand from standing stalks.
[2] Small grain threshed from shock.
[3] Greene County, Ohio; Ohio Agricultural Experiment Station Bulletin 396.
[4] No data available.
[5] Champaign and Piatt Counties; Illinois Agricultural Experiment Station Bulletin 329.
[6] Iowa County; Iowa Agricultural Experiment Station Bulletin 261.
[7] Kingsbury County; South Dakota Agricultural Experiment Station Bulletin 226.

SUPPLY OF CASH CROPS GROWN IN THE CORN BELT IN RELATION TO CONSUMPTION REQUIREMENTS

Reduction in the acreage or yield per acre of corn in the United States would probably result in higher prices if the demand remained as at present. Such a situation normally results in an increased use of substitute feed grains, principally oats and barley, especially for young stock and dairy cattle. The prices of these grains generally follow the trend of corn prices for this reason. Substitution of oats and barley for a part of the corn acreage, therefore, would not result in much lower prices for these grains. Less meat or livestock products could be produced, however, with the smaller amount of feed, and the farm income probably would be lowered if any large amount of this substitution were made.

The prices of the important cash crops are not determined by their feeding value. Increases in supply of these crops and their products, if there were no change in demand, would seriously disturb present price relationships. The relation of the current production of these crops to the existing requirements for human food and for other known uses, determines the extent to which their substitution for corn on any considerable part of the present corn acreage is economically feasible.

Some figures on the production and consumption of these crops are given below.

WHEAT

The average annual acreage of wheat in the United States during the five years 1924–1928 was 55,663,000 acres and the total annual production was 833,165,000 bushels. Wheat is the only strictly cash crop grown extensively in the Corn Belt. During these five years an

average of 25,628,000 acres was grown annually in the 11 Corn Belt States, an acreage equal to only 41.2 per cent of the acreage of corn. A large part of this is grown in the parts of these States outside the

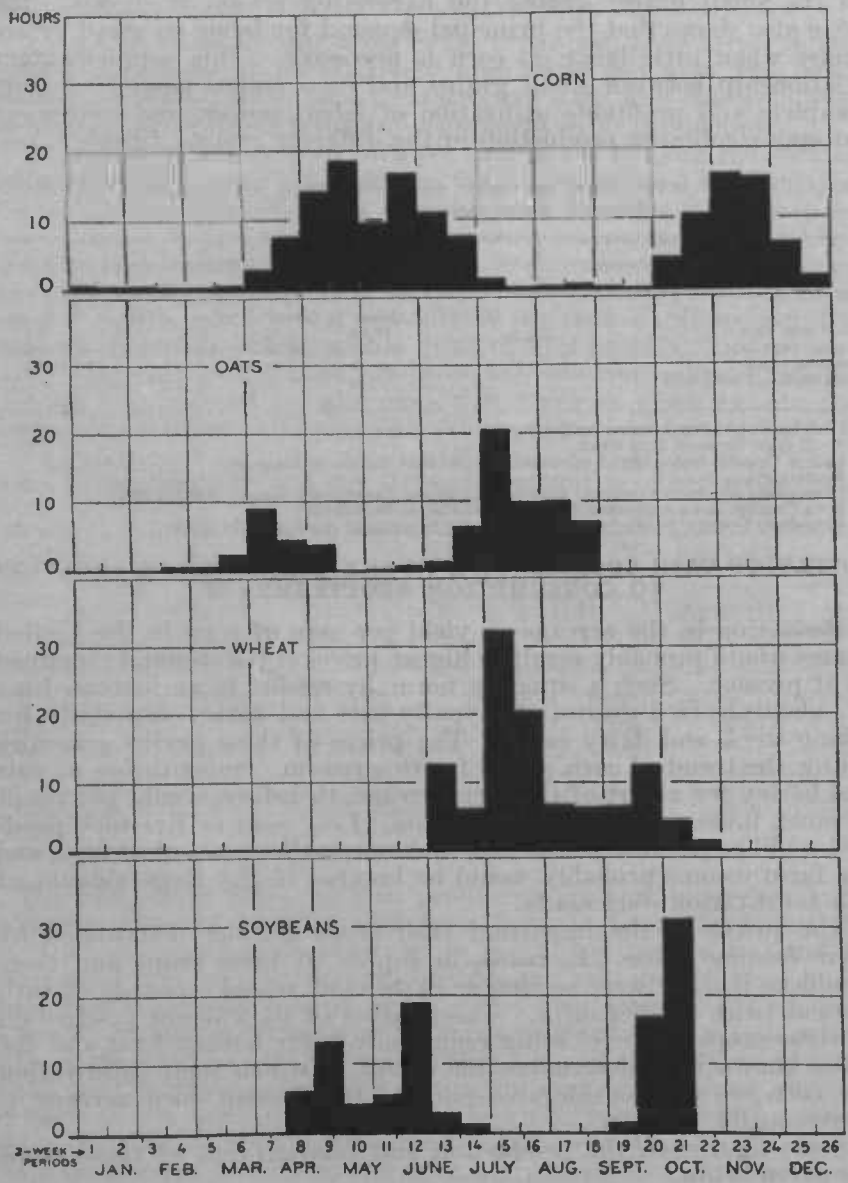

FIGURE 4.—DISTRIBUTION OF MAN LABOR USED IN GROWING AND HARVESTING 10 ACRES OF GRAIN CROPS IN EAST CENTRAL ILLINOIS

The labor on oats and winter wheat comes largely at a time when little is necessary on corn. Data from Illinois Agricultural Experimental Station Bulletin No. 329.

Corn Belt proper. Wheat is the principal bread grain of the American people, nearly 5 bushels per capita being consumed annually. From 1924 to 1928, inclusive, the United States exports of wheat and

wheat flour amounted to 21.3 per cent of the total production. About 10 per cent of the United States crop is required for seed, less than 5 per cent is used for feed, and the remainder, or from 60 to 70 per cent, is used for human food.

The relation between domestic production and requirements of wheat is clearly shown by the large part of the crop that is exported. Since one-fifth of our crop is sold on the world market the price received by wheat producers in the United States is determined largely by world supply and demand. Under the stimulus of high prices during the World War, the acreage of wheat in the United States was greatly increased by new land being brought into production. A considerable part of this new land is still being used for wheat production. The price of wheat during recent years has not been considered high enough to warrant any increase in acreage except under extremely favorable conditions. It is generally believed that little improvement in the price situation can be expected until the domestic requirements for food, feed, and seed, more nearly equal domestic production. Apparently there is now no real opportunity to substitute wheat for any major portion of the present corn acreage in the Corn Belt.

However, growing more winter wheat in certain districts would aid in controlling the corn borer because of the better distribution of labor. If it becomes necessary to reduce the corn acreage in order to clean up the stalk fields effectively, a fall-sown crop would distribute the labor in such a way as to reduce the amount necessary in the spring.

RYE

The average annual acreage of rye in the United States from 1924 to 1928, inclusive, was 3,766,000 acres. The greater value of other grains for feed and the decided preference of the American consumer for wheat flour have kept the production of rye at a low level. More than 90 per cent of the world rye crop is produced and consumed in Europe. During the war period, with increased foreign demand, the production in the United States increased rapidly but with the return to normal conditions has dropped to a little above the pre-war level. During the five years 1924–1928 the annual production was 50,851,000 bushels, about one-half of which was grown in the 11 North Central States. Nearly 48 per cent of the crop was exported during this period. Although inferior to corn, oats or barley as a feed grain, a part of the rye crop is fed. In 1924, with a short world crop, 76.7 per cent of the United States crop was exported. In 1925, with an estimated world crop 37 per cent larger, the United States exports amounted to only 27.2 per cent of the crop, and a much larger proportion was fed.

Rye is not at present considered a profitable cash crop if other small grains can be grown, and since foreign agriculture has recovered somewhat from war conditions there is little opportunity for substituting rye on any of the present corn acreage in the Corn Belt without decreasing the farm income.

SUGAR BEETS

The production of sugar in the United States was equal to only 17.6 per cent of the total consumption during the five years 1924–

1928. Insular possessions produced 28 per cent, and the remainder came principally from Cuba. Ninety-two per cent of the domestic production was beet sugar. The total acreage used in producing beets, however, was only 705,000 acres, or approximately 1 per cent of the acreage in corn. In the Corn Belt sugar beets are an important crop only in northwestern Ohio and adjoining sections of Indiana and Michigan. Here they are grown under contract with sugar factories, the price being set in advance, with a possible bonus depending on the sugar content and on the price of sugar at harvest time.

The average price received by the producer during the last few years has been from $6 to $7 per ton. At this price beets compare favorably with corn in value per acre after the necessary cash costs for labor, seed, fertilizer, machine hire, etc., are deducted. Other factors, however, make any great amount of substitution impossible. Sugar beets require a large amount of labor in growing and harvesting other than the contract labor used in blocking and thinning. They can be grown profitably only on soils of high natural fertility, and even then a considerable quantity of fertilizer is usually necessary. Climatic conditions also have a distinct effect on the sugar content. In spite of the small amount of sugar produced in the United States when compared with the domestic requirements for sugar, the demand for beets at present is limited, and any considerable increase in acreage would result in lower prices.

POTATOES

The average annual acreage of potatoes during the five years 1924–1928 was 3,363,000 acres, and the average annual production was 392,605,000 bushels. Potatoes are not an important commercial crop in the Corn Belt, the surplus-producing districts lying farther north than the latitude at which corn is at its best. A crop of about 400,000,000 bushels seems to be as large as can be marketed at prices satisfactory to the producers. Potatoes do not enter the export trade to any extent, the surplus above domestic requirements for food and commercial uses being fed to livestock or remaining unharvested. An increase in potato acreage amounting to only 1 per cent of the corn acreage would, with average yields, increase potato production by nearly 30 per cent and would result in ruinously low prices. Therefore, there seems to be no possibility of considering potatoes as a general substitute for corn under corn-borer conditions.

TOBACCO

The economic situation of tobacco is similiar to that of potatoes. The total annual acreage in the United States for the period 1924–1928 was 1,719,700 acres. Tobacco is not grown to any extent in the Corn Belt except in southwestern Ohio and the adjoining section of Indiana and in southern Wisconsin. About one-third of the tobacco crop is now exported, and stocks in the United States were 20 per cent greater on January 1, 1928, than five years earlier. Tobacco requires a great deal of labor and special equipment, and soil and climatic conditions have a distinct effect on the type and quality produced.

FRUITS AND VEGETABLES

Profitable production of fruit and vegetable crops on a commercial scale is dependent upon soil and climatic conditions, a relatively cheap supply of labor, and available markets. During the last 10 years improved refrigeration and transportation facilities have resulted in a great expansion of the small-fruit and vegetable industry in the South and West, where climatic conditions are most favorable.

During the five years 1924–1928 the acreage of 18 important vegetable crops averaged 2,169,932 acres. In the Corn Belt, production for immediate consumption is limited to small localities adjacent to large consuming centers. Vegetables for canning, however, principally sweet corn, tomatoes, cabbage, and green peas, are important crops in many districts. If favorable contracts for handling the canning crop can be secured and if labor is available for the hand work, these crops usually return a fair income. The location and capacity of canning factories determine the area where these crops may be grown profitably and the acreage which can be grown. Sweet corn is more susceptible to corn-borer damage than field corn and is thus eliminated as a possible substitute. The acreage of vegetable crops, both for canning purposes and for immediate consumption, may expand in the future, but only a very minor portion of the present corn acreage can be used for such crops if production is to remain profitable.

The production of tree fruits is an enterprise necessarily extending over a period of several years. The price received by producers of the principal fruits usually varies closely with the annual production. The general outlook is for continued heavy or even increased production of all the important fruits. With the relatively small acreage necessary to produce a crop sufficient to meet consumption requirements, and the trend toward the large specialized fruit farm, it is apparent that no opportunity exists to grow fruits on present cornland.

SOYBEANS

Soybeans have been grown for hay or as an interplanted crop in the Corn Belt for several years. Until recently the production of beans for grain, however, has been limited to those needed for seed, only the beans of poor quality being fed to livestock. Practically no soybean oil was manufactured in the United States until after 1921, when a tariff of 2½ cents per pound was put on imports. In 1922–23 about 1,482,000 pounds of oil was made from soybeans, and in 1928–29 this quantity had increased to 7,285,000 pounds. The increased use of soybeans for the manufacture of oil and for feeding has resulted in a larger acreage of beans being grown. Illinois, Missouri, Indiana, and North Carolina are the leading States in soybean production.

A considerable increase in soybean acreage may be profitably made in districts that are well adapted to the crop. In spite of the increase in oil production a considerable quantity of soybeans, soybean oil, and soybean-oil meal is imported each year. The value of the beans as a source of protein in livestock feeding is becoming more generally recognized. Although limited quantities may be fed to hogs the tendency of the whole grain toward producing soft pork makes the oil-meal cake, a joint product of the oil industry, more desirable.

The distribution and amount of labor required in the production of soybeans for grain is similar to those needed for corn, and no additional equipment is needed on the average farm. The total acreage of soybeans harvested for grain in 1928 was only 656,000 acres; if in the near future it were increased by only a very small part of the present corn acreage in the Corn Belt, the price of soybeans would be decreased.

OTHER CROPS

Flax, buckwheat, peppermint, and grass seeds are other cash crops that are grown in limited districts of the Corn Belt. The small acreage on which they are grown is sufficient to indicate the impracticability of substituting any one for any considerable part of the corn acreage.

Present domestic production of flax is less than one-half domestic requirements. Although a considerable increase in the acreage is ordinarily possible without reducing domestic prices to the world level, any such increases would logically be made in the area north and west of the Corn Belt.

Buckwheat is produced on scattered individual farms in all of the Corn Belt States but is of minor importance in any district.

Peppermint is grown on a commercial scale only on the muck land of southern Michigan and northern Indiana and is not a profitable substitute for corn.

POSSIBLE EFFECT OF CORN-BORER INFESTATION ON FARM ORGANIZATIONS

Unless there is a change in the market value of corn, any additional equipment or hired labor required to control the European corn-borer will result in lower farm incomes. Producers in uninfested areas will have a comparative advantage in corn production over those in infested areas because of the higher operating cost to the latter. The damage to the corn crop will be most severe in the best corn-growing districts where corn is most important in the cropping system. The acreage on the individual farm will be limited to that which can be properly cleaned up to control the borer. Should it become necessary, in order to secure adequate control, to reduce the acreage on the best corn-producing farms, some expansion probably will take place in other areas. A considerable amount of corn is now shipped into the Eastern and Southern States for feeding work stock and dairy animals. Higher corn prices, resulting from lower production in the Corn Belt, would induce producers in these deficit areas to more nearly balance their production and livestock feeding requirements.

The foregoing discussion indicates the probable results if producers follow their natural tendency to reduce the acreage of corn grown and substitute other crops. The results of such drastic changes in cropping systems are demonstrated in the results of a similar attempt by farmers in the southwestern part of Ontario, Canada. This region is similar to the Corn Belt of the United States in crops grown in the rotation. A complete loss of the corn crop occurred in many fields in this region as a result of severe corn-borer infestation during the period 1924 to 1927. The acreage of

corn grown in Kent and Essex Counties was reduced from 161,012 acres in 1924 to 47,527 acres in 1927. Investigations by the Agricultural and Experimental Union in 1926 showed that feed grains (oats, barley, and mixed grains) were sown on 46 per cent of the total acreage formerly planted to corn. Cash grain crops replaced corn on 29 per cent of the former acreage, 13 per cent was occupied by crops of high cash value (sugar beets, tobacco, and canning crops), 10 per cent was put into forage crops, and 2 per cent into soybeans, potatoes, and miscellaneous crops. It was estimated by the department of economics of the Ontario Agricultural College that this decrease in corn acreage would result in a decrease in the farm income equal to $5 per acre of cleared land.

A general clean-up program over the entire region was inaugurated in 1927, and, aided by climatic conditions unfavorable to the borer, has resulted in a much less severe infestation. The smaller losses from the borer damage in 1927, and the knowledge that control measures were more practical and economical than was substitution of other crops for corn, resulted in the corn acreage in the two counties being increased to 61,279 acres in 1928 and to 75,706 acres in 1929.

CONTROL OF THE CORN BORER

Practices which involve complete utilization or destruction of the corn plant and which have proved most practical and effective in destroying large numbers of borers are: (1) Feeding the entire corn plant as silage or fodder; (2) completely plowing under all stalks and other débris in the field, and (3) breaking or shaving, raking, and burning the stalks in the field. Control measures are almost equally effective at any time after the corn is harvested and before the adult insects begin to emerge in the spring, normally during the last 10 days in June. The control program, however, should be so planned that this work will be completed by May 1 in order to provide a margin of safety and to avoid conflict with the regular spring work.

The method of control used on the individual farm should be determined largely by the usual methods of harvesting the corn crop and preparing the corn ground for the following crop. Only a small part of the corn crop in the Corn Belt is usually cut for silage or fodder, and on most farms only a small part can be profitably utilized in this form. On land where corn follows corn in the rotation the ground is usually plowed but where the stalk ground is sown to oats it is only disked. In some districts the ground can not be plowed for oats because of soil and climatic conditions. On farms where the entire corn plant can be utilized as fodder [4] or silage, cutting may become more common under corn-borer conditions. (Fig. 5.) Where plowing is the usual method of preparing the ground for the following crop, no additional labor is necessary to control the borer except that needed in doing a better job of covering the stalks. (Fig. 6.) Plowing as now done on many farms will not be effective in controlling the borer. Where the stalks are usually disked for oats, plowing will ordinarily prove the most economical method of control. In those regions where stalk ground

[4] The Husker-Shredder on Eastern Corn Belt Farms, Farmers' Bulletin No. 1589.

FIGURE 5.—Where the fodder can be utilized in feeding, low cutting may be an economical method of control

FIGURE 6.—A clean job of plowing is effective in controlling the corn borer and requires little extra labor or costs

can not be plowed for oats, however, the stalks must be broken or shaved cleanly, raked and burned in the field before disking. (Fig. 7.)

The amount of additional labor necessary and the cost of the control program will vary from farm to farm. The method of clean-up may be different on each field of corn, depending on the way in which the corn was harvested and on the crop which is to follow corn. Cutting the corn for silage or fodder will entail more labor and cash cost than will husking in the field. It is doubtful whether, with present equipment, this method will be used unless the additional material can be utilized in feeding or for commercial purposes with a return

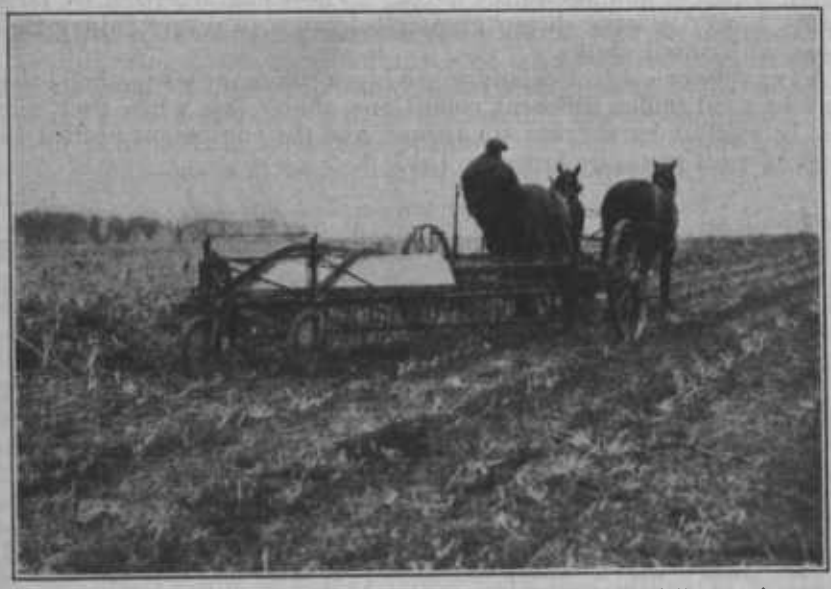

FIGURE 7.—Special stalk rakes with teeth close together or side-delivery rakes are most effective in this method of control

sufficiently great to offset the additional cost. Plowing the stalk ground which is normally disked and preparing it for seeding will require about 2 hours more man labor per acre when a 2-plow tractor is used in plowing. It has been estimated that an acre of cornstalks may be broken, raked, and burned with 4.2 hours of man labor and 4.4 hours of horse labor if efficient labor and equipment are used. Shaving instead of breaking the stalks will increase this time slightly. On many farms this additional work can be done by the regular workers on the farm and therefore will require no additional cash outlay. Where considerable numbers of livestock must be cared for, extra labor must be hired.

Development of new machinery for harvesting corn and for destroying the stalks in the field may prove an important factor in future corn-borer control. Although regular farm equipment may be used, if proper adjustments are made, purchase of some new equipment [5] may be justified. The standard corn binder will not cut the

[5] Circular 132, Fighting the Corn Borer with Machinery in the Two-Generation Area.

stalks low enough to give adequate control, but low-cutting attachments [6] which cut the stalks at the surface of the ground are now available. The field silage cutter, when equipped with a low-cutting attachment, is an effective control device and may prove practical on many farms. A special stalk rake, with teeth stronger and closer together, is more effective in raking stalks than the common hay rake. A low-cutting hand knife or hoe has also been devised, and a sled-type stalk shaver [7] for cutting the stalks before raking, may be made on the farm at small cost.

Aside from using mechanical control measures, there seems little that the farm operator can do. No variety or strain of corn has been found which is immune to the borer.[8] Those characterized by large stalks, however, have shown greater tolerance to severe injury than those with small stalks.

A corn-borer-control calendar, giving a summary of methods that may be used under different conditions, the season when they may best be used under average conditions, and the equipment needed for most efficient work, is shown in Table 4.

TABLE 4.—*The corn-borer-control calendar*

Usual methods of harvesting corn and preparing ground for following crop	Possible methods of clean-up	Season when work should be done [1]	Equipment needed	Estimated [1] extra-man labor per acre
(1) Corn cut for fodder or silage; ground may be either plowed or disked.	Cut corn at ground surface, clean up and burn all stalks not eaten by livestock unless well trampled in manure.	Cut as early in the autumn as possible when more borers are in upper part of stalks. Stalks around feed lots should be burned before May 1.	Low-cutting attachment for binder or special hand knife or harvesting hoe if cut by hand.	Only that necessary in cleaning up around feed lots.
(2) Corn husked from standing stalks by machines or hand; ground plowed.	Plow 6 to 8 inches deep. Do not drag stalks to surface in subsequent operations.	As much as possible in fall and remainder before May 1.	16 or 18 inch plow, rolling coulters, jointers, and covering wires.	Only that caused by deeper plowing and making more careful adjustments.
(3) Corn husked from standing stalks by machine or hand; ground disked for following crop.	Same as in No. 2 if corn ground can be plowed.	Same as in No. 2...	Same as in No. 2...	1.4 hours with tractor or 2.5 hours with horses plus same as No. 2.
	If ground can not be plowed, break both ways, or shave; rake both ways and burn.	As much as possible during winter when frozen and dry. All before May 1.	Stalk shaver, or breaking iron, stalk rake.	4.2 hours.
(4) Corn hogged or pastured off.	Same as in Nos. 2 or 3.	Same as in Nos. 2 or 3.	Same as in Nos. 2 or 3.	

[1] Although clean-up work may be delayed until later than May 1, some margin of safety should be allowed for in the control program.

ADJUSTMENTS FOR CORN-BORER CONTROL

Economic and biological factors affecting farming are constantly changing, necessitating shifts in organization and operation. The coming of the European corn borer will undoubtedly necessitate such adjustments—growing some other crop in place of corn or

[6] Miscellaneous Publication 56, Low-cutting Devices for Harvesting Corn.
[7] Miscellaneous Publication 142, Construction of Sled-Type Cornstalk Shavers.
[8] Researches are being conducted by Federal and State agencies in efforts to find or develop varieties which are more resistant or less attractive to the borer than are existing varieties.

adding the necessary control measures to the present farm operations. The farmer who meets these new conditions with the least additional cost or with the smallest reduction in income will be most sucessful under corn-borer conditions.

It is possible that oats and barley may be grown in place of a part of the corn in the Corn Belt, and substituted in the feeding program. But the decreased production of corn would result in its price increasing, and the higher price would be an incentive for growing as much corn as possible, especially in the cash-grain districts. Other cash crops apparently offer no real opportunity as substitutes for corn. The problem seems to resolve itself into a question of developing practices that will result in effective control of the borer so that the relative importance of corn in the rotation may be maintained. In the following pages the possibilities of adjusting the organization and operation of farms to meet corn-borer conditions by adding necessary control measures will be discussed. The amount and kind of equipment and the quantities of labor and power required under specific conditions will be estimated, as well as the actual money cost.

The organization on two farms—one a cash-grain farm and the other a livestock farm—will be used as examples in showing the possible adjustments in operation. The organization of these farms is typical of that on many successful farms in the important corn-growing regions. Consideration need be given only to those items of labor, power, and equipment required by the necessary added control measures and to those other changes following from such additions. It has not been thought necessary to compute farm earnings, either gross or net. It has been assumed that the addition of control measures will change the farm organization, the farm operation, and the subsequent farm earnings only in so far as noted in the bulletin.

It has been assumed that these farms are equipped to produce corn, hay, and small grain, as is the average Corn Belt farm. In estimating power and labor requirements it has been assumed that a tractor is used for plowing and that horses are used in all harvesting operations. The regular labor employed consists of the farm operator and a man hired by the month from March 15 to December 1. Other labor is hired by the day, as the necessity arises.

SUGGESTED ADJUSTMENTS FOR CORN-BORER CONTROL ON A GRAIN FARM

This is a 200-acre farm with the following acreages of crops and numbers of livestock:

	Acres
Oats (clover)	45
Oats (clover	45
Winter wheat (clover)	45
Alfalfa	10
Total	190

	Head
Horses	7
Cows	4
Brood sows	4
Pigs raised	30
Hens	100

The crop rotation, or sequence, is (1) corn, (2) corn, (3) oats (with clover or sweetclover for green manure), (4) winter wheat (with clover or sweetclover for green manure). The alfalfa lot is renewed as the necessity arises.

The cropping system used on this farm is common in districts in which winter wheat is successfully grown. One-half the crop land in the regular rotation is in corn, the other half in small grains. A small field of alfalfa provides hay for the work stock and milk cows. If legumes are seeded in all small-grain crops and plowed under, the maintenance of maximum crop yields is assured. Sweetclover is usually preferred as a green-manure crop, but red clover is often used if difficulty in growing sweetclover is experienced. In many parts of the Corn Belt winter wheat is not always a sure crop. On farms on which this is true, a 2-year or 3-year rotation of corn and oats with a legume seeded in the oats and plowed under for corn (corn, oats and sweetclover) (corn, corn, oats and sweetclover) is more common. If more than one-half the crop land is given over to corn, the advisability of continuing such a rotation should be carefully considered before attempting to work out a control program. Ordinarily, if a substantial increase in crop yields can be secured by using a longer rotation including more sweetclover or other legumes, the farm income may be maintained or actually increased, control of the borer will be facilitated, and better use of labor and equipment will be obtained.

On this farm all grain is sold except that needed for the work stock and other livestock kept to supply the home with livestock products and to consume the farm wastes. Over 80 per cent of the total receipts is from the sale of crops. The usual practice is to plow the 45 acres of oat stubble for wheat as soon after threshing as is possible. About 30 acres of wheat stubble are fall plowed for corn. The remaining 15 acres of wheat stubble and 45 acres of stalk ground are then plowed for corn in the spring. The other 45 acres of stalk ground are disked and sown to oats, with no other preparation. All of the corn is husked from the standing stalks, since on a grain farm there is no opportunity for the feeding of silage or fodder.

Under usual conditions 45 acres of stalk ground are disked and seeded to oats, and the other 45 acres of stalks are plowed for corn. This means no heavy peak load of labor in the spring. On a grain farm like this there is not enough livestock to make much work, so there is ample time during the winter and early spring season to do a considerable amount of clean-up work without hiring extra labor.

Control of the corn borer may be secured most economically on this farm by using one of two methods: Plowing under all cornstalks for both corn and oats; or plowing for corn as usual, but raking and burning the stalks preparatory to disking for oats. The choice of these methods may be determined by the effect which plowing has on the yields obtained from the following crop, usually oats. Where soil conditions are such that spring plowing is impossible or is detrimental to the oat crop, then the method of raking and burning the stalks and disking for oats must be used. In the case of the stalk ground that is to be planted to corn again the only requirement for control is to use proper care and equipment in plowing in order to insure the complete covering of all stalks.

Assuming that the stalk ground can be plowed with no detrimental effect upon the oat crop, the plowing of the 45 acres, usually

disked and seeded to oats, is estimated to require extra labor, power, and equipment as follows:

Man labor:

Plowing, 45 acres	7 days.
Harrowing, 45 acres	3 do.
Tractor use, plowing	7 do.
Horse work, harrowing, four horses	3 do.
Fuel for tractor	120 gallons.
Oil for tractor	7 do.

Additional equipment (assuming a 2-plow tractor is used): Two large rolling coulters, two jointers, and two covering wires.

These figures are based on the supposition that if the stalk ground is plowed for oats, the usual disking and an additional harrowing are also necessary before the oats are seeded. It is not believed that this additional work will present a serious problem. It can all be

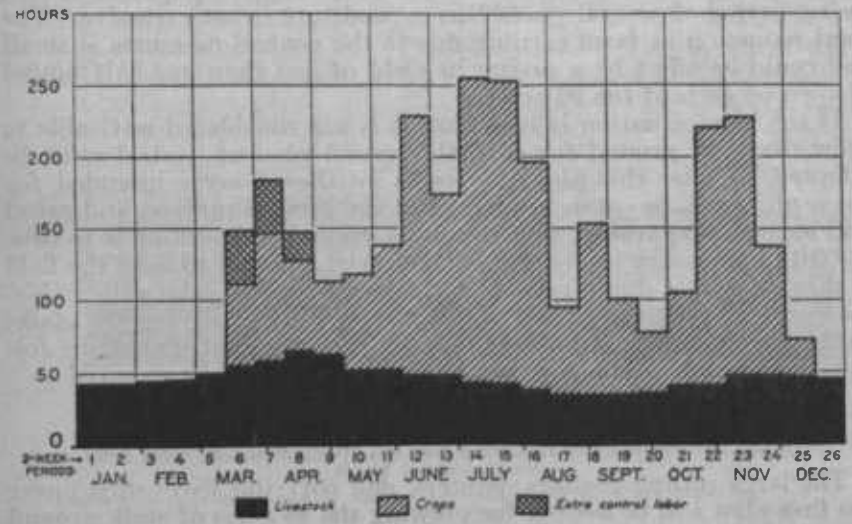

FIGURE 8.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE GRAIN FARM

Under this plan of control in which 45 acres of stalk ground are plowed for oats, the 10 days of additional work can be handled by the regular help.

done by the regular labor force if a part of the usual plowing for corn is delayed until after the oat ground is ready for seeding. Figure 8 shows the estimated amount and distribution of man labor on livestock and crops, and the additional labor necessary with this method of control. Some other work usually done between oat seeding and corn planting, such as fence building and repair, and machinery and equipment repair, may have to be done during the winter months or later in the season, but the additional time necessary for control is small as compared with the total time used in crop production.

The method of control as here outlined will have little effect on the farm earnings. It is estimated that the total additional cost, including that of materials purchased and depreciation on the additional equipment purchased, will be about as follows:

Fuel for tractor, 120 gallons at 14 cents	$16.80
Oil for tractor, 7 gallons at 75 cents	5.25
Depreciation	4.75
Total	26.80

Although the 10 days of additional work represent considerable effort, and on some farms it may be necessary to hire a part of it done in addition to that done by the regular labor, on this farm all of it is assumed to be performed with no additional cash outlay. Therefore this has no effect on the farm income. The same applies to the horse work. The added use of the tractor undoubtedly shortens the expected life of this machine, but it is not considered advisable to attempt here to estimate the small amount of depreciation. The fuel and oil used represent an actual money cost to the farmer. It is believed that the extra equipment needed can be obtained at a cost not in excess of $25 to $30. If the equipment is used over a period of several years, this expenditure is not excessive. The total reduction in farm earning due to the control measures is small and could be offset by a saving in yield of less than one-half bushel of corn on each of the 90 acres.

If the local situation is such that it is not considered advisable to plow the stalk ground for oats, the second plan of control must be adopted. Under this plan the stalks on the 45 acres intended for oat seeding will be cut or broken off at the ground surface, and raked and burned, preparatory to disking the ground and seeding it to oats. It will be necessary to break or shave the stalks and to rake the field both ways with a dump rake, or to follow the dump rake with a side-delivery rake, in order to do a complete job of gathering the stalks so they can be burned. Under this plan it is estimated that the following amounts of labor, power, and equipment will be required:

Man labor—breaking, raking, and burning 45 acres	27 days
Horse work—breaking, raking—2 horses	14 days
Additional equipment: Breaking iron or cutting sled, and stalk rake.	

The large rolling coulters, jointers, and covering wires used under the first plan will be needed for plowing the 45 acres of stalk ground for corn.

Considering that this work can be done at any time after corn harvesting, it at first seems the most economical method. Weather conditions[9] in the Corn Belt, however, are such that 8 to 10 of the 27 days of labor would have to be hired to dispose of the stalks on the 45 acres. The stalks can be broken effectively only when the ground is frozen. Cutting, raking, and burning can be done only under favorable weather conditions. Since only the operator is on the farm at this season some extra help will be needed.

In such case the cost of this method of control would be about as follows:

Extra hired labor, 10 days	$24.50
Depreciation	11.50
Total	36.00

[9] The Weather and Climate of Chicago. During the period 1871 to 1913 only 23 days on an average were clear during January, February, and March; 31 days were partly cloudy; and 36 days were cloudy. Rainfall was recorded on an average of 34 days and snow fell on 15 days. A mean temperature below freezing was recorded on an average of only 33 days.

The equipment necessary, in addition to that needed in plowing, a breaking or shaving tool and stalk rake, should be bought for $50 to $75. The cost of labor, figured here at 35 cents per hour, will vary somewhat in different districts, as will the amount of labor available. Although the estimated cost is greater under this plan than if the ground were plowed for oats, the clean-up work is all done before the regular spring field work begins (fig. 9), and no further adjustment in the usual plan of operation need be made.

It is obvious that if the control measures suggested in the above plans prevent even a small reduction in the yield of corn, their additional cost is more than justified. The cost of control, as measured by the reduction in farm incomes, will be greater on farms on

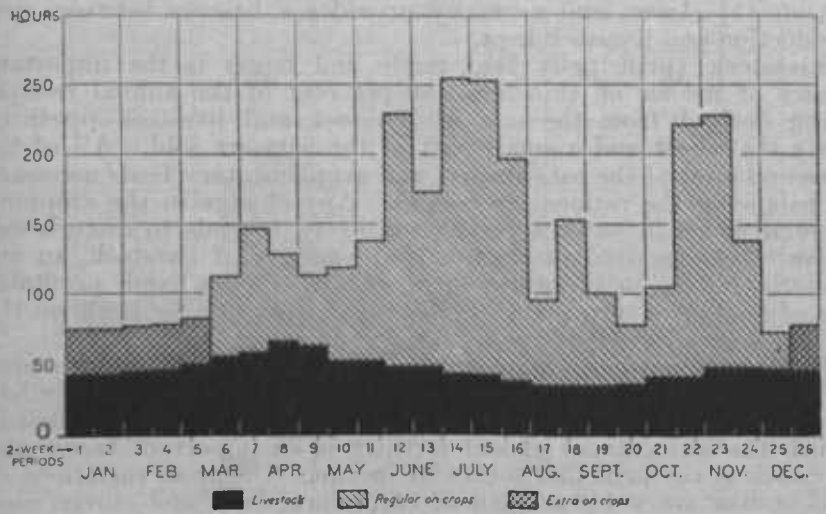

FIGURE 9.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE GRAIN FARM

Under this plan of control in which the stalks on 45 acres are raked and burned, and the ground is disked for oats, about 10 days of extra labor must be hired.

which a larger percentage of the crop land is in corn, or on which no fall-seeded crop is produced, as with the 3-year rotation of corn, corn, and oats. Here the spring labor is usually heavy and less time is available for the additional work demanded by the control measures. Under these circumstances a larger portion of this additional work must be performed by extra hired labor. On such a farm growing soybeans in place of a part of the usual oat crop may prove of value in reducing the amount of extra labor necessary and may be a profitable change. Although the labor on soybeans conflicts with that on corn (fig. 4) and plowing is necessary in place of disking, the later date at which soybeans may be seeded would give more time for the necessary labor on control work. In many districts wheat is sown on the soybean ground with little seed-bed preparation and may take the place of oats in the rotation, thus further reducing the spring-labor demand and providing a crop with an acre value usually higher than that of oats.

SUGGESTED ADJUSTMENTS FOR CORN-BORER CONTROL ON A LIVESTOCK FARM

This is a 200-acre farm with the following acreages of crops and numbers of livestock:

	Acres		Head
Corn	68	Horses	4
Oats	34	Cows	4
Wheat	34	Steers fed	20
Clover hay	17	Brood sows	15
Clover pasture	17	Pigs raised	125
Alfalfa	10	Hens	200
Total	180		

A 5-year rotation is used: (1) Corn, (2) corn, (3) oats, (4) wheat, (5) clover, and normally provides a balance between crop production and livestock kept.

Livestock (principally beef cattle and hogs) is the important source of income on this farm, 80 per cent of the annual receipts being derived from the sale of livestock and livestock products. Only the wheat and a small part of the oats are sold. All of the corn and most of the oats are fed, and supplementary feeds necessary in balancing the rations are bought. Any change in the cropping system, which lowers the production of feed, tends to disturb this balance between feed production and numbers of livestock, an unimportant item on the grain farm. On the other hand, profitable use of the entire corn plant as silage or fodder may be made on the livestock farm, a possibility not often existing on the grain farm.

The cropping system on this farm, with 40 per cent of the rotated crop land in corn, 40 per cent in small grain, and 20 per cent in hay and pasture, is one commonly used in those parts of the Corn Belt in which the maintenance of soil fertility is an important factor and livestock is the principal source of income. Common variations of this system are a 4-year plan of corn, corn, oats, and clover, used where wheat is not a sure crop, and the 4-year rotation of corn, oats and wheat, and clover, used where a part of the corn is cut for silage or fodder. The corn-stubble ground is disked and sown to wheat where this plan is used.

In the usual plan of operation as outlined for this farm about one-half the clover, or 17 acres, is cut for hay, and the remainder is used for hog pasture. The first-year clover in the wheat stubble also furnishes pasture after threshing, if needed. The 34 acres of oat stubble are plowed for wheat as soon after threshing as soil conditions will permit. After wheat sowing, the 34 acres of clover sod are usually plowed for corn. In the spring 34 acres of stalk ground are disked and seeded to oats and the remaining 34 acres of stalk ground are usually plowed for corn. It has been assumed here that all corn is husked by hand in the field, although on many farms a small acreage is often hogged off. This would make little difference in deciding on a method of control.

With this rotation, in which only 40 per cent of the crop land is in corn and in which the clover sod is fall plowed for corn, the spring field work normally is not heavy. The greatest peak load of labor comes during corn cultivation, hay harvest, and small-grain harvest. Extra labor is often necessary during this season. It must be remembered, however, that on this farm the time available during the

early spring for labor on crops is much less than that on farms on which little livestock is kept. This means that a larger part of any extra work due to corn-borer control measures must be done by extra hired labor than is necessary on grain farms.

The same methods of control outlined for use on a grain farm are applicable on farms on which livestock is more important. The possibilities of making profitable changes in the cropping systems are more limited on well-organized farms on which there is a balance between feed and livestock production, but changes in the method of harvesting the corn crop can often be made without disturbing this relation.

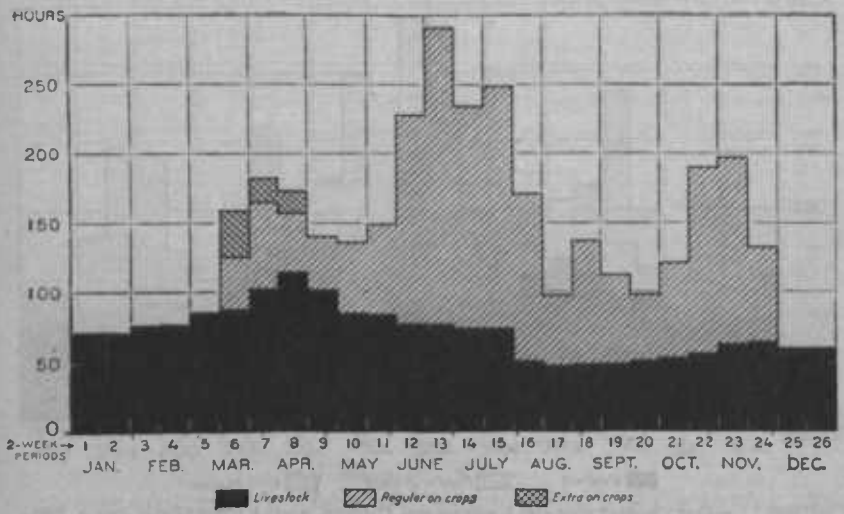

FIGURE 10.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

Under this plan of control in which 34 acres of stalk ground are plowed for oats, the eight days of additional work can be handled by the regular help.

Assuming, in considering a first plan of control, that the stalk ground can be plowed for oats with no serious difficulties, about eight days of additional work would be necessary in preparing the 34 acres for seeding. The estimated amounts of labor, power, and equipment necessary under this method of control are as follows:

Man labor:	
Plowing, 34 acres	6 days.
Harrowing, 34 acres	2 do.
Tractor use, plowing	6 do.
Horse work, harrowing, 4 horses	2 do.
Fuel for tractor	92 gallons.
Oil for tractor	5½ do.
Additional equipment: Two large rolling coulters, the jointers, and two covering wires.	

Under this plan the distribution of labor on this farm would be about as shown in Figure 10. The additional work is all done during the usual time for preparing the ground for spring seeding, and although greater effort is required of the regular help it is not necessary to hire additional labor. It may be necessary to shift other less important operations from one time to another.

The actual cost to the operator, then, is only that of fuel and oil for the tractor in plowing and of depreciation on the equipment necessary in control work. This is estimated to be about as follows:

Fuel for tractor, 92 gallons at 14 cents	$12.88
Oil for tractor, 5½ gallons at 75 cents	4.12
Depreciation on equipment	4.75
Total	21.75

While under the first plan the 34 acres of stalk ground may be plowed for oats with no additional hired labor, if as a second plan it becomes necessary to rake and burn these stalks, this additional

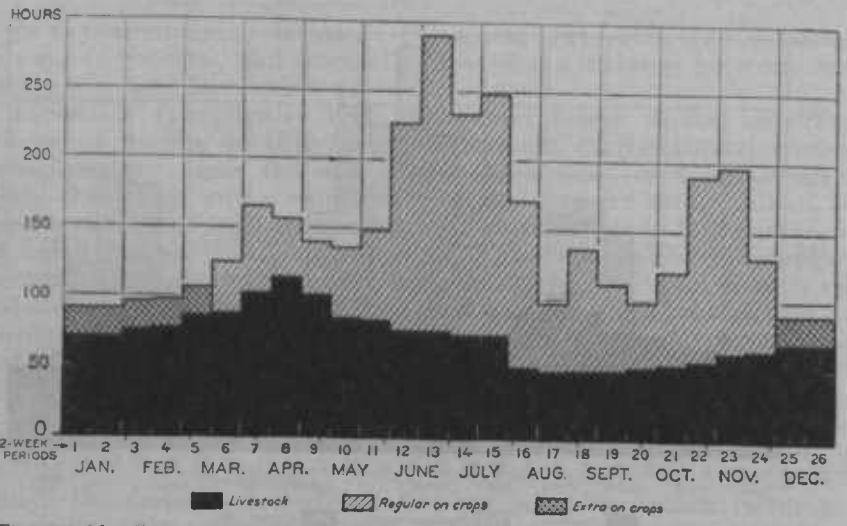

FIGURE 11.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

Under this plan of control in which the stalks on 34 acres are raked and burned and the ground disked for oats, about 21 days of extra labor must be hired.

work probably will have to be done by extra hired labor. The additional amounts of labor, power, and equipment necessary when this method is adopted are estimated to be as follows:

	Days
Man labor—breaking, raking, burning, 34 acres	21
Horse work—breaking, raking—2 horses	11
Additional equipment: Breaking iron or cutting sled, and stalk rake.	

The large rolling coulters, jointers, and covering wires used in the first plan will also be needed for plowing the 34 acres of stalk ground for corn. As is shown in Figure 11, this extra work all comes at a time when the operator is alone on the farm and when livestock requires the greatest amount of time. Raking and burning, if completed before oat seeding, must be done when weather permits during the winter and early spring. The extra cost of clean-up with this method is therefore greater than where the stalk ground is plowed for oats and is also greater per acre than on the grain farm where a greater part of the additional work can be done by the operator himself. This extra cost is estimated as follows:

Man labor, 21 days	$50.00
Depreciation on equipment	11.50
Total	61.50

On the basis of the foregoing estimates the cost per acre of controlling the corn borer is higher on livestock farms than on grain farms. The same equipment and methods of control are used on each, but because of the competition of livestock for the operator's time a greater part of the control work must be done by extra hired labor. Although the additional work, if performed by the regular labor, putting in more hours, has no effect on the farm earnings, as

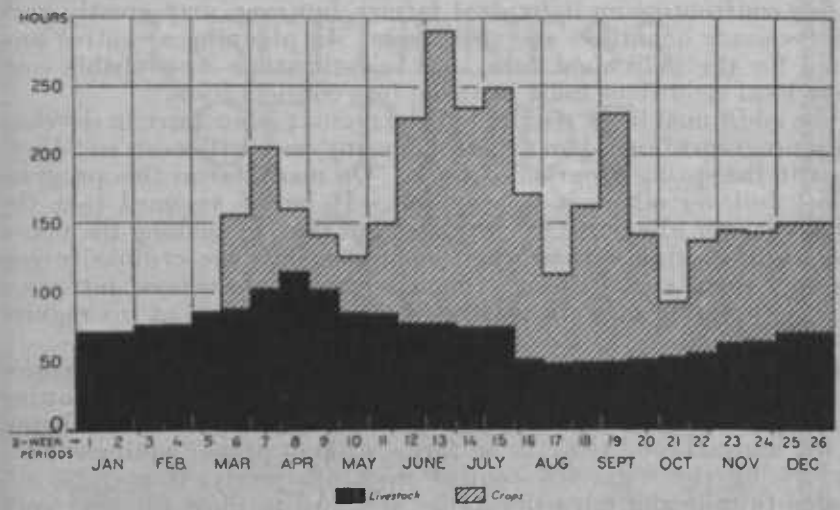

FIGURE 12.—DISTRIBUTION OF LABOR ON CROPS AND LIVESTOCK ON A 200-ACRE LIVESTOCK FARM

If 34 acres of corn are cut—10 for silage and 24 for fodder—and if 34 acres of stalk ground are plowed for oats, more labor is required in harvesting the corn crop but little extra labor is necessary in controlling the corn borer.

commonly calculated, the cost of labor hired in addition to the regular labor represents a cash expense that actually decreases the farm earnings.

If the livestock organization is such that changes may be made in the methods of harvesting the corn crop, and more of the corn fed as silage or fodder, a rotation of corn, oats, corn, wheat, and clover would give the same quantity of feed grain as is now produced. Under this plan, 34 acres of corn are cut—10 acres for silage and 24 acres for fodder. The wheat is then drilled into the corn-stubble ground without plowing. The oat-stubble ground and possibly a part of the clover sod may be fall plowed for corn, leaving only the 34 acres of stalk ground to be cleaned up for oats in the spring.

The estimated labor distribution where this cropping system is used is shown in Figure 12. Under this plan more labor is necessary in harvesting the corn crop than if the corn were husked in the field, but the additional work comes during a season when no labor is required on other crops. An additional month of hired labor may be necessary in the fall to husk the corn from the shock, and the added investment in a silo and silo-filling machinery will increase

the cost of operating the farm. Unless this additional outlay can be offset by a decrease in expense for other feed, or by increased sales of grain or livestock, the economic advisability of this method of control may be questioned. Cutting the corn for silage or fodder merely to control the borer can hardly be justified in view of the alternative methods of control open to the farmer.

FACTORS AFFECTING COST OF CONTROL

The quantities of labor and materials required for each method of control on the two farms used as examples were estimated on the basis of specified conditions. The local physical and economic situation confronting an individual farmer, however, may greatly vary the necessary quantities and their costs. In planning a control program for the individual farm and in estimating its probable cost, these local conditions must be taken into consideration.

The additional labor required of the regular labor force in developing a program of corn-borer control in many cases will mean an adjustment in the spring program of work. On many farms this program is not full, on others it is very full. It is not assumed that the farmer is ever idle during this period, but that, by making the necessary shifts during a time when labor demands are ordinarily less pressing than later, he can, without serious consequences, introduce into his program of work this extra effort demanded of his regular labor force.

In estimating the quantities of labor required on the farms used as examples it was assumed that sufficient care was taken in plowing and in raking and burning to obtain effective control of the borer. Under unusual conditions, or on farms without proper equipment for performing the suggested control work effectively, it may be advisable to rake and burn the stalks, and also to plow for both corn and oats. A saving of 2½ bushels in the yield per acre on the livestock farm would offset the cost of this extra precaution.

It was also assumed that plowing was done with a 2-plow tractor, and that horses were used in the lighter field operations. If no tractor is available for plowing, the quantity of extra work will be greater and more extra hired labor will become necessary, thus increasing the cost of control. The use of larger machinery in the regular field operations will decrease the amount of extra work necessary in control measures. Still more important is the development of new and more efficient machinery in cleaning up and destroying the cornstalks. Such machinery will make control work even more effective and will require less additional effort than at present.

It is to be recognized that some damage to the corn crop may develop under severe infestation even with the most careful clean-up program. The extent of damage under these conditions, however, will be far less if an effective control program is used than if all control measures are omitted. The cost of even the most detailed and carefully executed control program will be small in comparison with the loss that may occur without it. This fact seems sufficient reason why every Corn Belt farmer should have in mind a thorough clean-up plan which may be put into his farming program when the necessity arises.

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